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(54) **STM/ATM network interfacing**

(57) For many years yet, subscriber access to the network, for all but a few business sites will be on copper using the existing STM infrastructure. From this has been developed a bridging interface between an STM network and an ATM network. In this interface the information is carried in cells in fixed-size multi-octet timeslots, the cells being concatenated into packets having a two-octet header, the header including an address field, the packet size and a header parity bit. The header further includes a type field for use by external Adaption Layer Units.

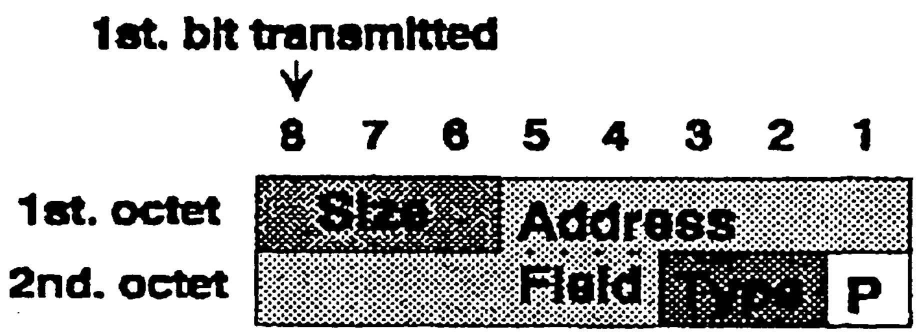


Figure 1a

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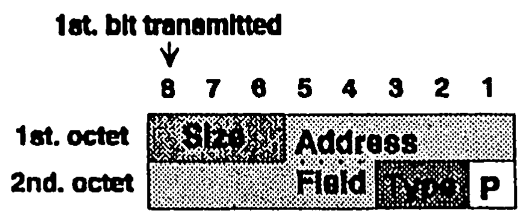



Figure 1a

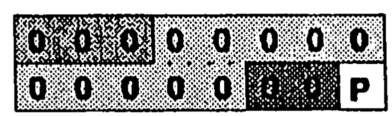
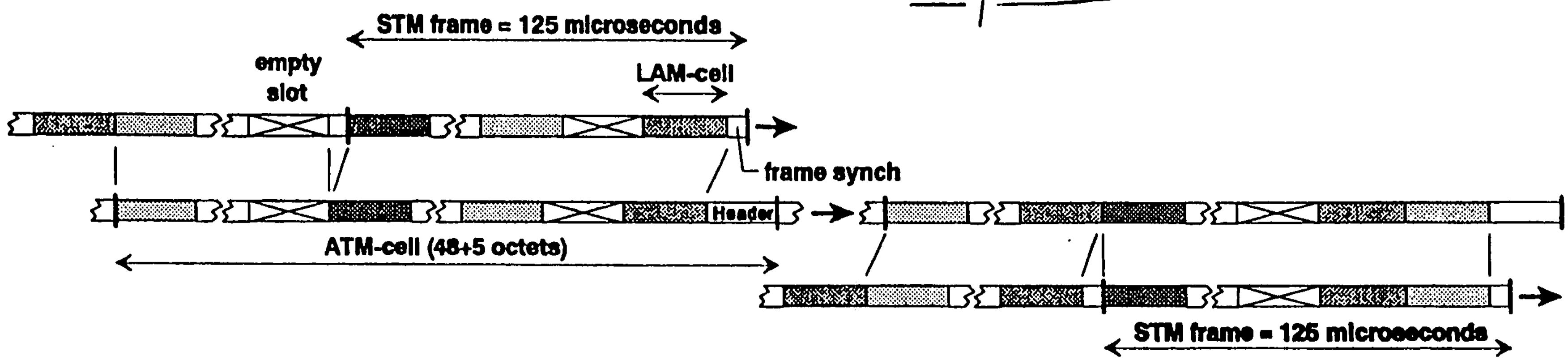



Figure 1b

Figure 2



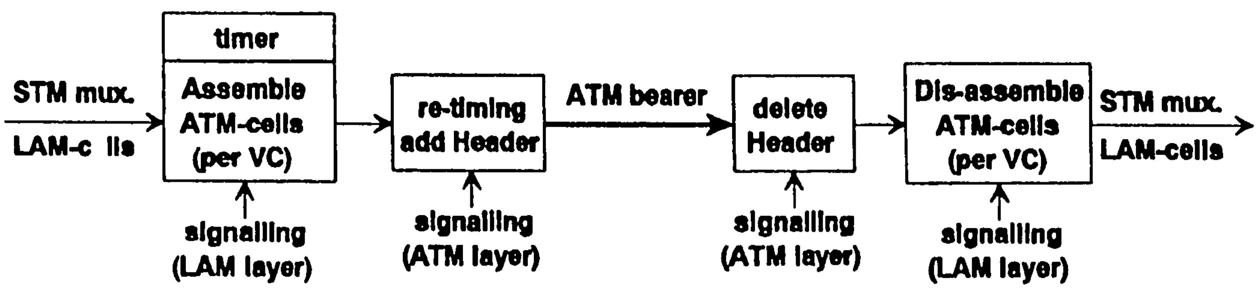




Figure 3

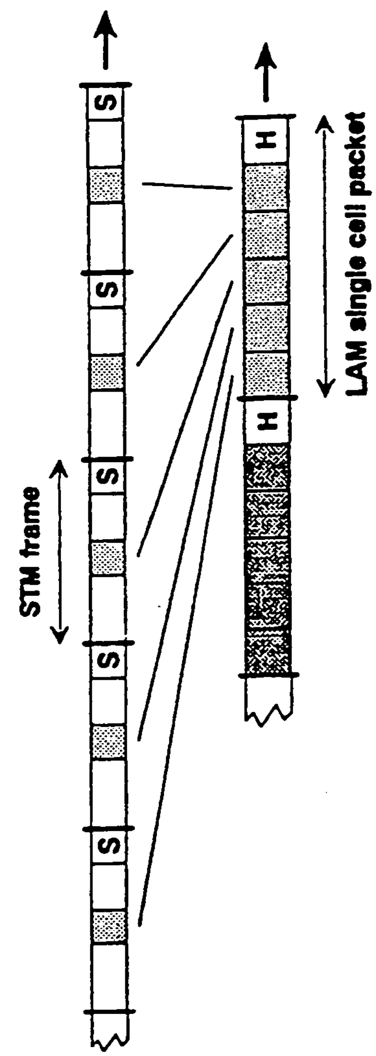



Figure 4

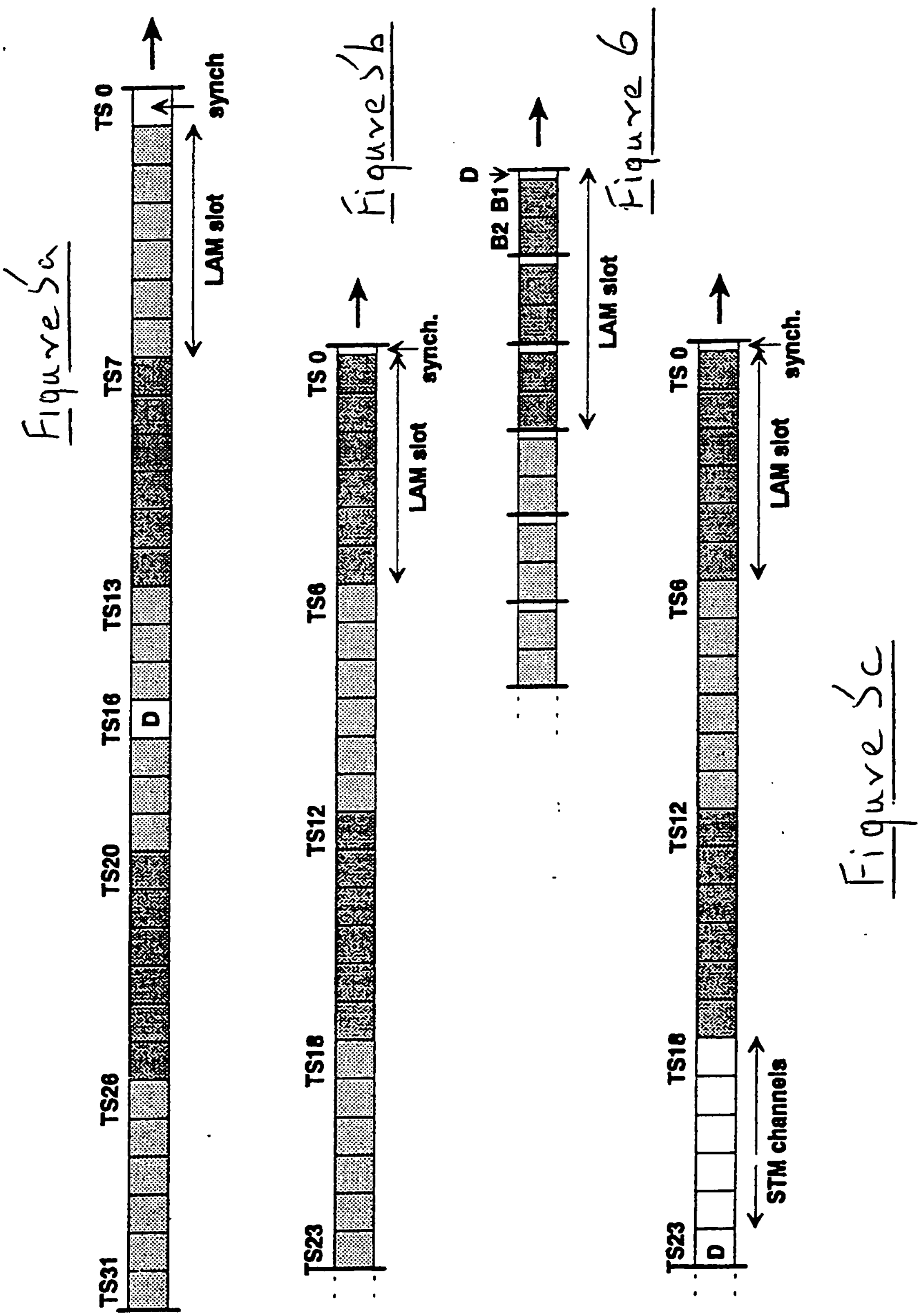



Figure 5a

Figure 5b

Figure 6

Figure 5c

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## STM/ATM NETWORK INTERFACING

The present invention aims to provide a more efficient medium for carrying a mix of services to a multi-media terminal. The technology has potential as a bridge between access on a conventional Synchronous Transfer Mode (STM) network and a core Asynchronous Transfer Mode (ATM) network allowing the resultant merged network to operate as a single network structure. With an emphasis on ATM as the single network technology of the future this role becomes of prime importance. The name given to this new bridging medium, is the Last-mile Asynchronous Medium or LAM, derived from its use for the last-mile using the present common copper wire connection.

For many years yet subscriber access to the network, for all but a few large business sites, will be on copper using the existing STM infrastructure.

The most used service will be voice but data traffic will grow, particularly for business users, until voice and data traffic in the public network is about equal by the end of this decade. An enabling feature will be a Multi-Media Terminal service and increasingly, as prices fall, this service will include a compressed video option. Whilst there are many ways by which multi-media terminals may be connected into the local networks on large business sites, the options available to the smaller business and to the public at large are severely limited by access constraints. This

problem is well recognised by British Telecom (BT) and by Bellcore who have collaborated in developing a "High bit-rate Digital Subscriber Line" (HDSL) technology. The data rates that can be achieved by this technology range from 400kbit/s over 5km to 800kbit/s over 3.66km (12kft). Present work is concentrated on a T1 equivalent on two pair but future work will be on an enhanced basic-rate 6B+D line which should eventually replace the present 2B+D standard, with early trials in about 2 years time; some semiconductor manufacturers are already looking at the possibilities for integrated line interfaces and it has been shown how a 6B+D internal interface may be provided over two GCI (IOM2) channels. Six B-channels can provide a bearer for asynchronous services (i.e. packet-mode channels and variable-bit-rate channels) at 384kbit/s and this is sufficient to serve a multi-media terminal including compressed video.

After so much effort has been spent on improving the physical medium to achieve higher digital throughput it would be sinful to waste this effort by using inefficient means in the higher layers to convey the services required by a multi-media terminal. Since nobody can predict beforehand how these services will be mixed in a session it is obvious that dynamic sharing of the available bandwidth must be used, and this implies an asynchronous medium. There are two technologies available to provide protocol-transparent asynchronous communications and these are Frame-Relay and ATM.

One of the services to be carried is voice and it is now well recognised that a voice-on-ATM service using the full capacity of the ATM cell results in delays which can seriously impair service quality when there are several ATM to STM conversions in a path, as is likely in the early days of ATM and particularly on international calls. The voice service therefore calls for shorter cells, but then the header represents a very severe overhead. In the access medium only, and for a particular service (i.e. voice) the header size could be cut down severely. The arrangement described suggests that a two byte header will give adequate flexibility in the access medium.

The other services to be carried do not usually need such short cells, with the possible exception of data service responses; the access bandwidth can therefore be used more efficiently for these services if a range of packet sizes are available. Frame-Relay provides for variable length packets but the High-Speed Date Link Control (HDLC) protocol which is used to identify the start and

finish of packets requires an additional one byte of overhead for an "end-flag" and it would be advantageous if this can be avoided. ATM carried on a Synchronous Digital Hierarchy (SDH) STM-1 bearer uses the frame synchronisation indication and a counter to delineate cells. All possible STM bearers provide a frame-synch indication and, if there are an integer number of fixed size cells in each frame, a similar arrangement to the ATM/SDH solution can be used. For larger packets these basic cells may be concatenated with a single header per packet if the header includes a length indication.

An integer number of basic cells must fit into one STM frame for as wide a range of frame formats as possible.

An integer number of basic cells must be a good fit for an ATM-cell Information Field.

LAM technology provides a smooth fit to both STM and ATM networks for the following reasons :

LAM-cells are a good fit for both STM frames and ATM cells.

The LAM provides an asynchronous, protocol transparent, medium as does ATM.

Single cell LAM-packets reduce packetisation delay for CBR voice services from 6mS (64kbit/s voice-on-ATM) to 0.5mS (4 samples plus two octet header).

LAM technology can be used to interface POTS services to an ATM network without serious impairment.

Virtual channels can be carried transparently from an end-point in a terminal on the STM network via an ATM core network to the destination end-point.

According to the present invention there is provided an STM/ATM network interface wherein the information is carried in cells in fixed-size multi-octet slots, the cells being concatenated into packets having a two-octet header, the header including an address

field the packet size and a header parity bit.

Additionally the header may include a typefield used by external Adaption Layer Units.

A packet preferably contains between one and eight cells.

Preferably a cell comprises six octets.

Such an interface may be used for customer access to an STM network.

Alternatively, the interface may be used to interface narrowband STM services to an ATM core network.

The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1a shows the Header format for a LAM cell;

Figure 1b shows the Header format of Figure 1a for an empty cell;

Figure 2 shows a diagrammatic representation of the transfer of LAM-cells via an ATM layer;

Figure 3 shows diagrammatically the major functions involved in interfacing LAM-cells on an STM bearer to ATM;

Figure 4 shows the use of a packetisation function to interface POTS services to an ATM layer using single-cell LAM-packets;

Figure 5a shows a representation of LAM slots filling a 30B+D multiplex;

Figure 5b shows a representation of LAM slots filling a 24B T1-carrier multiplex;

Figure 5c shows a representation of LAM slots partially filling a 23B+D multiplex, and

Figure 6 shows a representation of LAM-cells filling 3 frames of a 2B+D multiplex for ISDN Basic Rate Access.

The chosen LAM-cell size is 6 octets since this is able to fully fill a range of standard STM multiplex formats i.e. 6B+D, 12B+D, 30B+D and 24B will also fit eight into one ATM-cell. Note that no additional overhead is needed in the ATM-cell information field since the use of LAM-cells on a Virtual Channel is implicit.

Note that, although an STM frame and an ATM-cell information field must each carry an integer number of LAM-cell slots, LAM-packets can cross STM frames and ATM cells; packet delineation is dealt with in a later section.

The Header format, shown in Figure 1a, assumes that a

The Header format, shown in Figure 1a, assumes that a two-octet header is an acceptable overhead for a LAM-packet.

Note that a single parity bit is the only protection given for address errors; anything more would be an unacceptably high overhead. The Error rate in the STM/ISDN access network is assumed to be low enough for this solution to be acceptable. Parity is over the whole header; the choice of odd or even parity is to be determined. Empty cell slots are identified with the reserved address "all zeroes", as shown in Figure 1b.

Size Field:
Identifies the number of LAM-cells which form the LAM-packet; the range (N) is from 1 to 8 cells which provides a payload of 6N - 2 octets.

Address Field:
Provides for up to 1,023 virtual channels on one LAM bearer.

Type Field:
This field is used by external Adaption Layer units; the usage is adaption layer dependant, e.g. to indicate First, Middle, Last and Single-Packet segments of a PDU.

User services which might be carried in LAM cells are :

Constant Bit-Rate (CBR) voice:
The normal telephone service.

Packetised or Variable Bit-Rate (VBR) voice:
A service where voice traffic can be dynamically shared with other services on a common bearer; silent periods are suppressed resulting in less than half the average bandwidth of a CBR service being occupied (e.g. CCITT G.764 and G.727).

Variable Bit-Rate Video:
The bandwidth occupied is a function of the amount of movement on the screen.

Graphics:
Proprietary solutions.

Data:
Using an Ack/Nak flow-control loop and windows (end-to-end protocol) to correct errors and to control the flow of data.

Multi-Media:
A mixture of the above services dynamically sharing the bearer bandwidth.

Use of LAM-cells in the customer access has been described above, but another application is in interfacing normal narrowband STM services onto an ATM core network. This is particularly advantageous for the CBR voice service where the use of small (6 octet) LAM-cells embedded in an ATM bearer channel means that the principal problem with voice-on-ATM is almost elminated since the packetisation delay is reduced from 6mS to 0.5mS for single cell LAM packets (four samples) or to 1.25mS for two cell LAM packets (10 samples).

The transfer of LAM-cells via an ATM layer is shown in Figure 2.

Empty LAM-slots may be deleted at the ATM interface but a timer must be included to prevent undue delay and jitter whilst accumulating a full ATM cell load, else the quality for CBR and VBR services may be severely compromised; particularly voice.

The major functions for interfacing LAM-cells on an STM bearer to ATM are shown in Figure 3.

For interfacing Plain Ordinary Telephone System (POTS) services to an ATM layer using single-cell LAM-packets, a packetisation function must be added as shown in Figure 4.

The location in the network of a POTS to LAM-cell and hence to ATM interface is important since, to fully utilise an ATM virtual channel without compromising the delay reduction resulting from using LAM-cells, there needs to be a substantial community-of-interest between the ATM layer end-points so that most ATM-cells can be filled with eight LAM-cells. Single cell LAM-packets used to provide POTS services may be mixed with variable size LAM-packets from other

sources in order to increase the community-of-interest between ATM layer end-points.

LAM-cell slots can be delineated easily as already described by counting from the frame-synch marker, but the LAM-packet header is only carried once in each packet. Once a LAM-packet header has been identified, following packet headers can be found using the SIZE field; but first it is necessary to find a valid packet header.

The packet header carries a parity bit, but there is a 50% probability that parity may be emulated in data octets; it is therefore necessary to make a number of checks to ensure that the provisionally identified position is correct and the following mechanism is one alternative.

1. The first two octets of each LAM-slot is searched for a pair where parity is correct.
2. A 4-bit counter is incremented by one (up to its limit value of 15) and the location of the SIZE field is read (NB unused values in the translator will be marked).
3. The SIZE field is used to identify the (supposed) first word of the next packet.
   IF parity is correct, go to (6).
4. IF parity is incorrect OR the translator indicates a spare code AND the count field is $<4$ THEN reset counter AND go to (1).
5. IF parity is incorrect OR the translator indicates a spare code AND the count field is $>3$ THEN decrement count by 4.
6. IF the count is $>7$ THEN set the PACKET LOCK flag ELSE reset PACKET LOCK flag.
7. Go to (2).

It will be seen that eight successes will result in the "Packet Lock" indication and packets can be read. There is less than a 1 in 256 chance (depending upon how many address values are in use) of an incorrect lock. The normal value of the counter in the locked state will be 15 and two successive failures will take it out of the locked state.

Examples of LAM Packets on Standard Multiplex Formats are shown in Figures 5a-5c.

In all the cases the frame-rate is 8khz; frames are shown

delineated by lines extending above and below the time-slots.

In all the above cases the available time-slots in the frame are fully filled with LAM-slots. Figure 5c shows one example of partial fill for a 23B+D multiplex where the remaining five STM time-slots are available for providing standard 64kbit/s channels via an STM network.

In order to provide full format flexibility a parameter (24 bits in the above case) is set up by the control whenever the format is changed; the bits are individually associated with the 24 STM time-slots and a "1" is set in every bit position occupied by a LAM time-slot; the remainder of the bits are set at zero. This parameter is used to provide identification of LAM slots on the multiplex.

Note that, with this parameter, the individual time-slots forming a LAM slot need not be adjacent; this allows for some freedom in formatting in a dynamically changing environment. Note, however, that for LAM slot delineation it is still necessary to maintain an integer number of LAM slots per frame.

Partial fill with LAM slots is not limited to the above case but for a 30B+D system the above parameter needs to be 30 bits long. For the purpose of standardising this parameter a length of 31 bits would serve all possible multiplexes to European and North American standards, for rates up to 2048kbit/s (NB. the 32nd. time-slot in the European format will carry frame-synch, essential to the operation of the LAM).

For LAM-cells on a 2B+D ISDN Basic-Rate Access the LAM cell occupies three frames as shown in Figure 6.

A multi-frame synchronisation signal is needed in order to delineate LAM-cells and fortunately such a signal is available. The American National Standards Institute (ANSI) standard for the U-interface calls for provision of an "Embedded Operations Channel" (EOC) management channel. This channel uses a 12-frame multi-frame and, although the EOC channel is (believed) not to be used by European operating companies, the semiconductor manufacturers which supply the line-interface chips are keen to address the US market thus this feature would be included in the chip design.

## CLAIMS

1. An STM/ATM network interface wherein the information is carried in cells in fixed-size multi-octet time slots, the cells being concatenated into packets having a two-octet header, the header including an address field, the packet size and a header parity bit.

2. An interface as claimed in Claim 1, wherein the header further includes a type field for use by external Adaption Layer Units.

3. An interface as claimed in Claim 1 or 2, wherein the packet contains between one and eight cells.

4. An interface as claimed in any preceding claim, wherein a cell comprises six octets.

5. An interface as claimed in any preceding claim and providing customer access to an STM network.

6. An interface as claimed in any one of Claims 1 to 4, and providing an interface for narrow band STM services to an ATM core network.

7. An interface substantially as hereinbefore described, with reference to and as illustrated in the accompanying drawings.

**Patents Act 1977**
**Examiner's report to the Comptroller under**
**Section 17 (The Search Report)**

Application number
GB 9219647.6

| Relevant Technical fields | | | Search Examiner |
|---|---|---|---|
| (i) UK Cl (Edition | K ) | H4P (PPA, PPEC, PPS) | K WILLIAMS |
| (ii) Int Cl (Edition | 5 ) | H04L 12/46, 12/48, 12/56, 12/66 | |
| **Databases (see over)** | | | Date of Search |
| (i) UK Patent Office | | | 5.11.92 |
| (ii) | ONLINE DATABASE: WPI | | |

Documents considered relevant following a search in respect of claims 1-6

| Category (see over) | Identity of document and relevant passages | Relevant to claim(s) |
|---|---|---|
| A | EP 0468818 A2 (NEC CORP) see abstract | 1 |
| A | WO 90/07832 A1 (BELL/ALCATEL) see abstract | 1 |

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| Category | Identity of document and relevant passages | Releva to claim(s) |
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